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UNITED STATES DEPARTMENT OF AGRICULTURE

BUREAU OF ENTOMOLOGY

FOREST INSECT INVESTIGATIONS

RELATION BETWEEN TEMPERATURE AND EFFECTIVENESS OF PINE BARK OIL FORMULA 21046/R ON DENDROCTONUS BREVICOMIS BROODS.

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RELATION BETWEEN THE RATIOS AND PROPORTIONS
OF THE SEXES FROM EGGS LAID
IN CONFINEMENT AND UNDISTURBED BROODS.

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Berkeley, California
March 20, 1934

[illegible] OF THE [illegible] OIL PLANTS 21046/2
ON [illegible] AND ON VISCOSITY [illegible].

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RELATION BETWEEN TEMPERATURE AND EFFECTIVENESS OF PINE BARK OIL FORMULA 21046/R ON [illegible] BROODS.

INTRODUCTION

Field and laboratory tests with certain toxic oils as a means of western pine beetle and mountain pine beetle control were carried on jointly by the Standard Oil Research laboratory and the Bureau of Entomology during 1932 and 1933. Barrel house oil, formula 21046/R, was found to give the most uniform and effective results. Certain limitations of its use, however, were indicated with the discovery that a higher percentage of beetle broods was killed when the oil was applied during the summer months in comparison with results obtained by fall applications. Thus it was assumed that temperature differences play an important part in determining the efficiency of the oil.

To test the relationship between temperature and effectiveness of oil 21046/R against western pine beetle broods, a series of experiments was carried on this winter by a cooperative arrangement made between the Bureau of Entomology and W. W. Gay of the Standard Oil Research laboratory at Richmond, California. These experiments resulted in a definite correlation between temperature and brood mortality. Temperatures between 70 and 90 degrees Fahrenheit gave the best results. Mortality following an exposure of one week to temperatures below 50 degrees was found to be negligible. This resulted in further tests to determine:

1. Whether a prolonged exposure to temperatures of 50 and below would increase mortality.

2. Whether mortality was increased by raising the temperature in the bark for a short period, following a prolonged exposure to low temperatures.

All tests were run under controlled conditions of temperature and humidity provided by the laboratory facilities of the Standard Oil Company and the University of California. Mortality data were secured by Bureau of Entomology personnel.

The amount of oil to be used in these tests was determined as a result of experience gained by certain oil control projects in the field during the 1933 summer season*. The average amount applied was calculated at 80 grams per square foot, or .023 gallons, an amount equivalent to 9.2 gallons per 1,000 board feet. An over-dosage of 120 grams per square foot was used in all tests to get a comparative record of kill, and to make certain that lack of sufficient oil would not be a factor in results.

*Patterson, J. E., Preliminary Results of Oil Treatment of Ponderosa Pine Infested with D.b., and of Sugar Pine Infested with D.m.
Struble, G. R., Memorandum Oil Control Bass Lake.

METHODS

Material

Heavily infested ponderosa pine bark of uniform texture and thickness from Bass Lake, California, was used. The brood stages varied between 3/4 and fully-grown larvae. The bark was cut into measured samples having an area of one square foot each. Three square feet were used in each temperature test with oil applications as follows:

Sample 1. Oil 21046/R applied to outer surface of bark only by means of a brush, with a consumption of 80 grams. (This is a normal application based on field experience.)

Sample 2. Oil 21046/R applied to all surfaces by means of a paint brush, with a consumption of 120 grams. (This is an overdosage calculated to secure an extreme condition.)

Sample 3. Untreated bark subjected to the same temperature conditions as treated samples to check normal mortality.

Equipment.

Temperatures of 60, 65, 70, 80 and 90 were procured by a specially constructed cabinet at the Standard Oil Research laboratory. Constant temperatures were maintained by thermostatic control. Ventilation of the cabinet was provided by an electric fan to prevent any damaging influence on the experiment as a result of fumigation. Humidity was maintained between 45 and 50 percent.

Constant temperatures of 32, 40, and 50 degrees Fahrenheit were provided in the refrigeration rooms at Hilgard Hall located at the University of California.

Procedure

All bark samples were cut and oiled at the Standard Oil laboratory. Reserve bark was stored at 32 degrees Fahrenheit to keep the broods in hibernation.

Experiment A. To determine the mortality of broods in oiled bark following a short period of exposure to 90, 80, 70, 65, 60, 50, 40 and 32 degrees Fahrenheit (the period was set at 1 wk. as a result of data on field experience). One set of 3 samples was run each week, until the test was completed through 60 degrees Fahrenheit. Then the sets at 50, 40 and 32 degrees were run during the same week in refrigeration rooms at Hilgard Hall. With the run completed for each set, the bark was analyzed immediately to determine the mortality of broods.

Experiment B. To determine the effect of oil on broods exposed to prolonged exposures of 50, 40 and 32 degrees Fahrenheit. Oiled and untreated check samples were placed in rooms at these temperatures and left for a period of 21 days, following which they were analyzed for brood mortality.

Experiment C. To determine the effect of oil on broods exposed to prolonged cool temperatures of 32, 40 and 50 degrees F., then removed for a short period to a constant temperature of 75 degrees Fahrenheit. Prepared bark samples were placed in the refrigeration rooms for 21 days, then were taken to Richmond where they were placed in the constant temperature cabinet, set at 75 degrees and left for a period of seven days.

RESULTS

Tables 1, 2, and 3 present the results of these experiments. The following points were found to be most significant:

1. An exposure of one week at temperatures between 70 and 90 degrees Fahrenheit produced the highest mortality of broods. Samples with an overdosage resulted in 100 percent kill at these temperatures, while the normal dosage produced from 67 to 93 percent kill.

2. An exposure of one week to temperatures of 60 and 65 degrees F. resulted in an appreciable reduction in mortality. Normal dosages produced from 55 to 58 percent kill, while 69 to 78 percent mortality occurred with the overdosage.

3. No appreciable killing was found for either dosage at 50, 40 and 32 degrees Fahrenheit when exposed for a period of one week.

4. A prolonged exposure of 21 days at the lower temperatures had no effect in brood mortality at 32 and 40 degrees Fahrenheit, but produced an appreciable kill at 50 degrees F.

5. A short exposure of 7 days at 75 degrees Fahrenheit, following a long exposure of 21 days at 32, 40 and 50 degrees F. was sufficient to cause high mortality, showing that the toxic qualities of the oil are retained over extended periods.

6. Overdosages of oil caused higher mortality in all cases above 50 degrees F.

7. No effect from fumigation was shown in any of the untreated check samples.

8. These results point to one more test requiring a longer period of exposure to temperatures between 60 and 70 degrees F.

Figures 1, 2, and 3 present graphically the results obtained in these tests.

TABLE I — MORTALITY AFTER ONE WEEK

° F.	80 Grams						120 Grams						Check					
Constant	Living Brood: Larvae			Dead Brood: Larvae			% Mort.	Living Brood: Larvae			Dead Brood: Larvae			% Mort.	Living Brood: Larvae			Dead Brood: Larvae			% Mort.
	0-	½-	1-	0-	½-	1-		0-	½-	1-	0-	½-	1-		0-	½-	1-	0-	½-	1-	
32	18:	215:	0:	4:	11:	0:	6.04	10:	115:	0:	15:	25:	0:	23.63	26:	135:	0:	0:	4:	0:	3.45
40	7:	10:	0:	7:	127:	0:	11.35	1:	139:	0:	8:	18:	2:	14.60	37:	137:	0:	4:	2:	0:	3.33
50	9:	135:	0:	8:	12:	0:	12.10	2:	120:	0:	7:	6:	0:	9.63	72:	192:	0:	3:	4:	0:	2.38
60	5:	44:	0:	1:	86:	0:	1.89	1:	43:	0:	7:	106:	0:	4.89	50:	190:	0:	0:	3:	0:	1.23
65	5:	132:	0:	7:	96:	1:	4.55	1:	35:	0:	0:	129:	0:	4.73	18:	144:	4:	1:	2:	0:	1.11
70-74	3:	59:	0:	4:	121:	0:	6.67	0:	0:	0:	7:	170:	0:	0.00	4:	104:	4:	0:	0:	0:	0
80-81	2:	10:	3:	0:	20:	213:	0:	0.93	0:	0:	0:	0:	5:	209:	0:	11.00	7:	54:	139:	0:	4.5
90-93	0:	42:	2:	0:	0:	271:	0:	13.83	0:	0:	0:	0:	2:	217:	1:	0.00	16:	167:	2:	0:	1.0

TABLE II — [illegible] AFTER 10 DAYS, AND MORE, AFTER 3 [illegible]

32	5:	202:	0:	0:	4:	8:	0:	5.43	0:	196:	2:	3:	12:	53:	0:	1:24.7	34:	188:	0:	3:	0:	0:	0:	0
40	4:	111:	1:	1:	4:	11:	0:	13.3	2:	228:	0:	0:	0:	29:	1:	0: 6.46	42:	339:	1:	5:	3:	6:	0:	2.3
50	1:	100:	0:	2:	1:	40:	0:	5:30.3	20:	124:	0:	2:	53:	32:	0:	3:45.11	34:	207:	1:	5:	13:	1:	0:	5.3

TABLE III — MORT. OF BROOD AFTER ASCENDING OF ONE HOUR TO 95° F., FOLLOWING 21 DAYS OF RETURN.

32	9:	18:	88	0:	3:	182:	0:	0:75.0	0:	56:	0:	0:	204:	0:	1:86.42	13:	13:	89:	0:	10:	11:	1:	1:	16.6
40	0:	20	29:	0:	22:	157:	0:	8:78.60	0:	6:	0:	0:	5:	122:	0:	7:95.7	6:	20:	172:	0:	0:	12:	3:	2: 7.9
50	1:	4:	38:	0:	40:	131:	3:	8:84.2	0:	1:	0:	0:	8:	146:	0:	4:99.4	11:	20:	122:	0:	9:	5:	0:	0: 7.2

P* — Pupae A* — Adults

CONCLUSIONS AND FURTHER INVESTIGATIONS

1. The use of oil 21046/R as a means of bark beetle control is limited by the temperatures prevailing within the bark. The application of oil during the summer season should be most effective, and results thus far have shown this to be true.

2. Fall applications of oil as a rule will show variable degrees of killing, due to the fluctuation of temperatures which are generally too low to cause heavy mortality. The effect on overwintering broods may not be shown until a rise in temperature in the spring. Whether oil retains its toxicity throughout the winter is a matter for conjecture at present, but field examination this spring of infested trees treated in the fall of 1953 should determine this point.

3. Further tests in the field are necessary to determine in addition to temperature influences, the importance of bark texture and thickness on oil penetration and effectiveness. Since bark of uniform texture and thickness was used in these experiments, neither was a factor in the results obtained.

4. The results obtained by an extended exposure of oiled bark at 50 degrees Fahrenheit, point to a further experiment requiring longer exposures held at 60, 65, and 70 degrees F. The fact that prolonged exposure to 50 degrees produced an appreciably higher mortality, emphasized the need for a prolonged test on temperatures between 60 and 70, since the temperature of bark under field conditions often remains within this range for extended periods.

Day, M. F. The Pine Beetle Problem. Research and Development Department, Standard Oil Company, Richmond, California. December, 1932. (Unpublished Report.)

Patterson, J. E. Preliminary Results of Oil Treatment of Ponderosa Pine Infested with Dendroctonus brevicomis, and of Sugar Pine Infested with Dendroctonus monticolae. Berkeley, California. January 17, 1934. (Unpublished Report).

Salman, K. A. Further Tests of Oil Sprays to Control the Western Pine and Mountain Pine Beetles. Berkeley, California. August 12, 1933. (Unpublished Memorandum).

Struble, C. B. Preliminary Results of Oil Treated Ponderosa Pine Infested by Dendroctonus brevicomis and Melanophila gentilis. Berkeley, California, December 15, 1933. (Unpublished Memorandum).

FIG. 2

MORTALITY OF D. BREVICOMIS BROODS IN TREATED PONDEROSA PINE BARK AFTER THREE WEEKS OF EXPOSURE TO CONSTANT LOW TEMPERATURES OF 32, 40, AND 50°F.

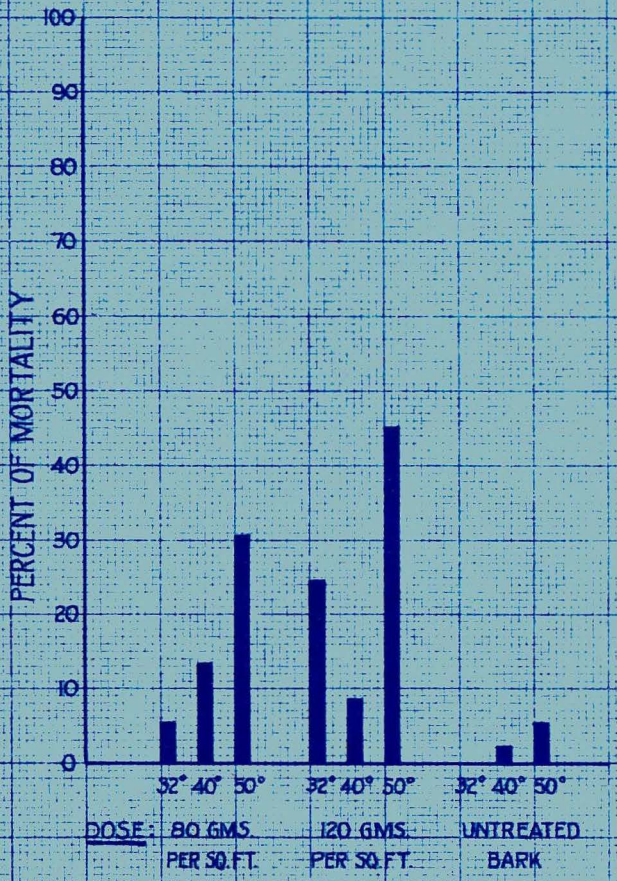

FIG. 3

MORTALITY OF D. BREVICOMIS BROODS IN TREATED PONDEROSA PINE BARK AFTER EXPOSURE OF ONE WEEK TO 75°F. FOLLOWING THREE WEEKS OF EXPOSURE TO CONSTANT LOW TEMPERATURES OF 32, 40, AND 50°F.

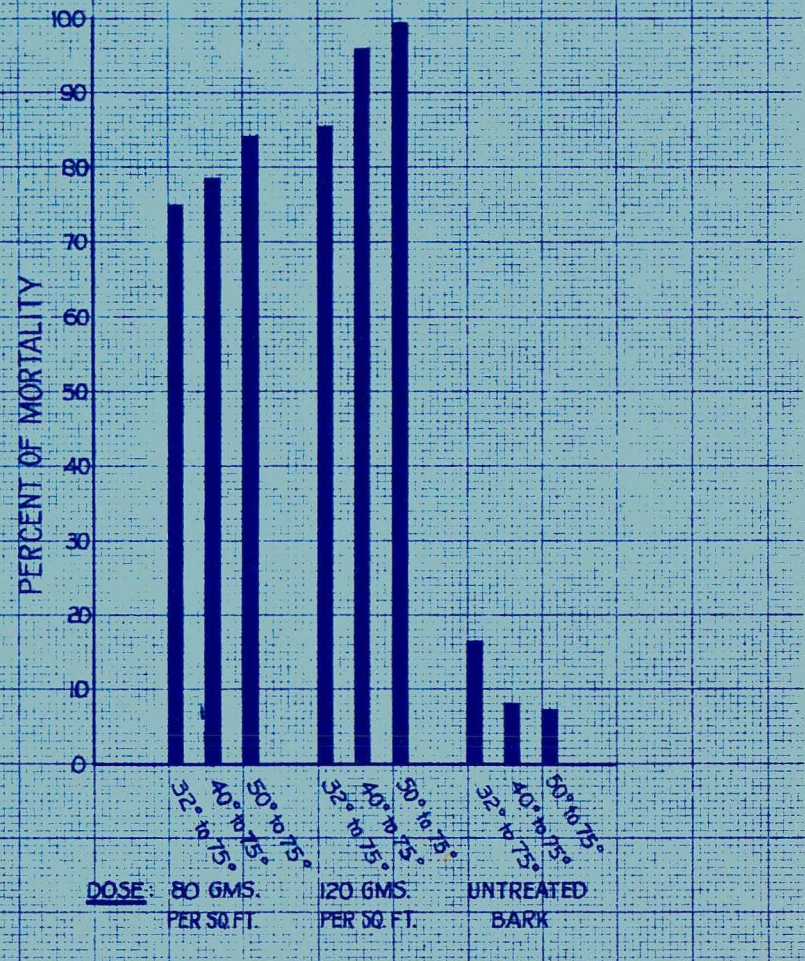

FIG. ONE

MORTALITY OF D. BREVICOMIS BROODS IN TREATED PONDEROSA PINE BARK SAMPLES AT TEMPERATURES OF 32-90°F. (HUMIDITY 45-50%)